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STRUCTURAL DETAILS FROM 1926 PARIS AERO SALON

By W. Rethel

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STRUCTURAL DETAILS FROM 1926 PARIS AERO SALON.*

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The criticism of German specialists on the tenth Paris Aero Salon is, in general: "Nothing new in airplanes to be seen." For reasons easily understood, the French would hardly exhibit their most modern military airplanes. The French commercial airplanes shown in the salon are already well known in air traffic. Since the German commercial airplanes have been far better developed, due to greater technical requirements, the judgment of the professional world "Nothing new" is even here thoroughly justified.

Although the other nations (English, Dutch, Italian, and Czechs) offer nothing special, it may nevertheless be of interest to discuss a few structural details, in order to learn the tendencies of foreign airplane construction.

Very many French pursuit and combat airplanes are high-wing monoplanes. This is due to the good visibility of this type. Since it is very difficult to protect the wings of high-wing monoplanes against distortion, some French constructors employ a method of wing trussing which is disliked in Germany, in order to ameliorate this disadvantage. The landing gear is included in this wing trussing, so that the landing-gear axle or its fair-

*"Konstructive Einzelheiten aus dem Pariser Aero-Salon." From "Zeitschrift für Flugtechnik und Motorluftschiffahrt," February 14, 1927, pp. 53-57.

ing becomes a part of the supporting structure. The endeavor to place the lower member of the wing trussing as low as possible is noted both in the high-wing monoplanes and in the braced or semicantilever biplanes. Fig. 1 shows eight different airplanes with this kind of wing trussing. The upper and lower members of the truss are drawn heavier for the sake of clearness.

This cell structure is accompanied, however, by a great complication of the landing gear, so that it is doubtful as to whether it is advantageous for all airplanes. It is very well suited to small airplanes, such as the Nieuport-Delage "Jockey," since the suspension strut is here quite steep and can be carried past the wheels to the junction points of the landing gear. The lower member is also suited to large high-wing seaplanes, like the "Besson," since it affords a convenient support for the lateral floats, which it is otherwise difficult to obtain in this type of seaplane.

Béchereau and De Mureaux use a number of struts with very expensive junctions and shock absorbers, in order to carry the trussing past the wheels through the landing gear. Breguet has developed a good spring wheel for the same purpose, so that he can join the trussing directly to the rigid axle. Levasseur dispenses with the axle and wheel springs and likewise joins his bracing, which passes through the lower wing, to the rigid axle. This has the disadvantage, however, that all the starting and landing shocks are transmitted undamped to the wing cell,

which may cause unavoidable injuries.

Endeavors are everywhere being made to improve the landing-gear shock absorbers. The old type of rubber shock absorbers is now but little used. The present endeavor is to distribute the landing shock uniformly between separate rubber strands, which are fastened independently of one another, so as to furnish sufficient shock absorption, even when one strand is ruptured. Béchereau locates the shock absorber in a very broad strut (Fig. 2). The strut carries five yokes, to each of which two strands are attached both before and behind. The ends of these twenty strands are bound about pins, which are attached to the strut by suitable fittings. The whole mechanism is protected by sheet iron. The principle is good, but the construction difficult, since forty attachments must be made for each wheel. Moreover, the separate strands are bound for about 2/3 of their length, so that only the remaining free third of the strand can stretch properly or else the strands stretch inside the whipping, in which case they soon become loose. Fokker, in his F VII, has adopted a similar device (Fig. 3), but he uses closed rubber rings, thus doing away with the bound loops. This device is extremely simple, making it seem strange that Bechereau did not use these rings, which, having originated in England, are now also being made by a French firm. These rings, like the cables, consist of many small rubber cords and are spun in this form.

Morane-Saulnier, like Béchereau, places the shock absorbers in the protected struts, but the two telescope tubes each have one broad yoke to which the above-described rubber rings are attached before and behind.

I will briefly describe two types of metal floats. The outer form of the Breguet metal float is very similar to the American Glenn Martin float: half-round on top, with a somewhat keel-shaped bottom. Behind the step, the bottom slopes upward too fast toward the rear. The half-round shape has, for seaplanes of 2000 kg (4400 lb.) and upward, the advantage, as compared with rectangular floats, of not having an unnecessarily large capacity with a high step. The inner structure of the Breguet float has, like its American pattern, a central girder, which utilizes the whole height of the float and thus affords great longitudinal stability. The bottom has internal and the top has external longitudinal stiffening members. The two strips between these stiffening members on the top, on the right and left of the central girder, are bolted to the adjacent strips and not riveted to the transverse frames. Thus the float is accessible throughout its whole length, which is very important for its production and upkeep.

The single float, exhibited at the stand of the Avimeta Company, is made of "alferium" and has about the same shape of the bottom as the Breguet float, but its cross section is trapezoidal and narrower on top. The transverse frames are therefore of

somewhat simpler structure than the half-round ones. The float has more manholes which, together with its large size, render it very accessible. It was very neatly finished.

Fokker exhibits a well-developed all-steel tail skid on his CV. The rubber shock-absorbing cables lie in the direction of the skid and are attached to eyelets in the fuselage in such a way as to be easily exchanged. The skid is steerable and can be turned about its longitudinal axis by means of a lever and cable. At its lower end it carries an exchangeable shoe. A little above the latter there is attached a very simple and practical emergency brake, consisting of a claw which can be released by the pilot by means of a cable (Fig. 4). It is being used on Dutch military airplanes.

In contradistinction to the complex structure of the Fokker skid, Fig. 5 shows the primitive Potez skid. On the under side of the fuselage there are two bearing-like brackets for receiving the cross rod about which the rubber cable is wound. The rod is fastened to the brackets by bolts. In order to avoid the tying of knots in the shock-absorbing portion of the rubber cable, the latter is attached to the pivot of the tail skid.

Fig. 6 shows a Fokker-Jupiter device for the installing of a radial engine. It is made entirely of welded steel tubes. Nine bracket-like pieces of sheet metal are welded to a steel-tubing ring and receive the main engine-fastening bolts. This ring is braced against the four fuselage junction points by means

of six tubes which are welded to the ring at three points. The rigidity is further increased by cross struts. The fork-like connections consist of pieces of thick sheet steel welded to the outside of the tubes. The welded joint of the cross pieces is strengthened by welding on a star-shaped piece of sheet steel. The whole assembly has a very simple and rigid appearance and, due to its open structure, affords easy access to the magnetos, carburetors and oil pumps.

Fig. 7 shows a Potez-Jupiter engine support of sheet duralumin. It is of very simple construction and affords satisfactory rigidity with relatively few rivets. The frustum of a cone is formed out of 3-4 mm (0.12-0.16 in.) sheet duralumin, which carries, on the inner side of its small end, a riveted flange on which are mounted the nine brackets for receiving the engine bolts. The base of the cone runs out into four arms, to which are riveted the pieces which serve for the fuselage attachments. The four arms are strengthened by double angle strips riveted to the outside. The rigidity of the arms is further increased by bending their sides so as to form right angles at the tips.

The engine cowling is fastened chiefly by hinge strips, which run the whole length of the cowling. The hinge strips are joined by running steel wires through them. This method was employed by Fokker two years ago, but was subsequently abandoned, due to the excessive weight, since he had used brass hinges. The engine cowling exhibited had hard-aluminum hinges, which

were not so heavy.

To fasten the cowling, Fokker now uses single lugs about 20 cm (7.87 in.) apart. At corresponding intervals the cowling has holes reinforced by hollow copper rivets. The cowling is secured by strong pins stuck through the lugs. This method is very simple and sure, but, on account of the projecting lugs, does not present so elegant an appearance as the hinges.

The Breguet method of fastening the cowling differs from the ordinary method. The cowling consists of strips of very thin sheet dural joined together by inside crimping. The sections made from these metal strips have a more or less rectangular shape and are surrounded by a flanged metal frame. Strong metal segments with inwardly bent flanges are riveted to the four corners of each section. If four such sections come together they form a ring, which, with its flanged edge, is held in a cup-shaped socket attached to the framework of the fuselage. The flanged edges of the segments are pressed into the socket by a washer and nut. Fig. 8 shows such a fastening with half of the cowling removed in order to give a better view of the socket. The segments may also consist of 1/2 or 1/3 circles according to where they are used. The method is good, but expensive and suitable only for mass production.

The Fiat single-seater has an extremely well-shaped engine cowling behind the frontal radiator, the cowling being so close to the cylinder blocks that the air from the radiator can es-

cape easily. The accessibility to the spark plugs is good, since they project through correspondingly large openings in the cowling and can be exchanged without removing the latter.

For the fuselage framework, the so-called "wood and wire" type of construction is much used in France. In Farman's commercial airplanes there are several remarkable examples of this type of construction. Brace wires run across the door openings for cabin and baggage room and, in using the doors, must first be removed by an easily operated device. This method is employed even on the most recent one-engine commercial airplane "Jabiru," in which the cabin walls curve outward. In order to save room, the upholstered seats are crowded into the curved side walls, so that the wire intersections in the cabin pass through the upholstery of the inner arms of the chairs. In order to improve the appearance, the wires are wound with plush. The whole structure gives the impression that the necessary wire bracing was first thought of after the cabin equipment was finished and that the chairs then had to be perforated in order to pass the wires through them. It can hardly be imagined that a German constructor would venture anything of the sort.

The fuselage of the Nieuport-Delage pursuit single-seater is covered with plywood and linen, which gives good lines and a smooth surface. The accessibility for installing and repairing is, however, very poor.

Breguet, De Mureaux, and S.E.C.M. exhibit light-metal struc-

tures. The junctions of a Breguet fuselage consist of stamped light-metal flange assemblies. The fields are braced with steel wires. The junctions make a very good impression but are exceedingly expensive for small-scale production. The opinion is often expressed that Breguet's airplanes are designed especially for mass production. This applies only to his factory equipment. With good equipment and mass production, even the most complex parts can be cheaply made.

The S.E.C.M. uses principally dural tubing for the fuselage framework and has developed clamp-shaped pressed pieces for the junctions. The production is very expensive, since a different stamping machine must be made for every junction with a different angle. There can hardly be any question of mass production for the giant airplane exhibited. We question whether a simpler type of junction would not serve equally well. In any case, the work at the drawing board and in the workshop excites admiration.

In contrast with this, the fuselage of De Mureaux is very poor. This fuselage is likewise made of dural tubing (Fig. 9) and the junctions consist of sheet-metal strips, which are attached to the fuselage girders by means of very small screws and interposed filling pieces. For greater safety, they are also fastened together by several long rivets. The ends of the diagonal bracing tubes of the fuselage walls are square and are attached to the junction strips by tubular rivets, the number of rivets being in no proper proportion to the cross sections of

the diagonal struts. The crude workmanship indicates little experience.

The Fiat fuselage has a steel-tubing framework consisting of four longerons connected by zigzag diagonal struts. The junctions are not welded, but hard-soldered with sleeves. Over this steel-tubing framework there is laid a very neat lattice-work of light metal (Fig. 10). This consists of vertical rib-like members and horizontal members which are corrugated to increase their rigidity. The vertical members are attached to the longerons by means of small brackets which are soldered to the steel longerons and riveted to the vertical strips. This lattice-work is covered with doped linen.

Fiat and Besson exhibit a wing structure. This is all-metal, the spars being of steel and the ribs of duralumin. Fig. 11 shows a junction of a Fiat spar and rib. The spar consists of two U-shaped strips with their flanges riveted together. This produces a favorable thickening of the material at the top and bottom where the stresses are greatest. The webs have triangular openings whose edges are bent inward thus forming rigid diagonal braces. The ribs are braced girders with top and bottom members of square dural tubing, the different members being joined by means of riveted dural junction plates. Evidently a good riveting machine was used, as the work is very neat. The ribs are secured to the spars by saddle-shaped junction plates with tubular rivets. The ribs are also strengthened by steel

brace wires. For this purpose, all the rib flanges are drilled at the same point and a steel wire is passed through all the holes. Small disks are soldered to the wires on each side of the flange, so as to prevent any lateral yielding. The whole structure impresses one as having been carefully thought out.

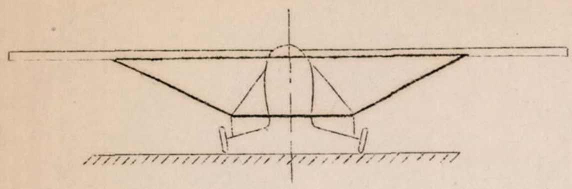
Besson exhibits an all-wood structure in his large boat seaplane. The wing spars have the form of box girders with plywood webs. They are very narrow and high. The ribs consist of flanges and diagonal braces. The flanges themselves have a U-shaped cross section and consist of two wood strips and a many-holed web. The flanges and diagonals are joined by means of plywood junction pieces. On every rib there are very many glued joints, which should be avoided on a seaplane. The same structural method is also employed in the tail, which is especially exposed to contact with water.

De Mureaux exhibits an especially interesting duralumin spar (Fig. 12). The webs of this spar are made of thin sheet dural with top and bottom edges bent outward at right angles. The webs are joined together by many small bolts and distance tubes. The flanges of this spar are reinforced toward the middle, corresponding to the greater stresses, in a very practical way. The top of the flange, at its outer end, consists of a U-section, which, as shown in Fig. 12, is inserted between the webs, to which it is joined at short intervals by small bolts with distance tubes. Toward the middle, the outer edges of

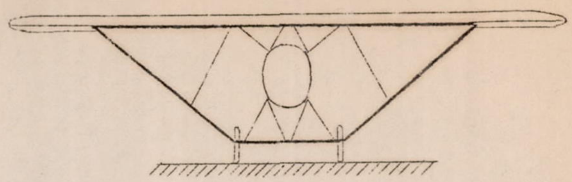
U-sections are so wide that a flange strip can be riveted to them, a second flange strip being added to the most stressed portion. In order to prevent any local bending of the edges of these flange strips, the first strip is crimped against the web. This firm also exhibits a dural rib, the flanges and diagonals consisting of small U-sections. At the junctions, one U-section is inserted in the other and secured by only a single rivet. The construction is very simple, but the riveted junctions are not commensurate with the relatively strong diagonals. The tail planes exhibited by De Mureaux have a similar structure. It is of interest to note that not the whole of the horizontal stabilizer is adjustable, but only the leading edge, by means of spindles.

On the large commercial airplane of the S.E.C.M., the framework of the central section of the wing is exposed. The spars, like those of Junkers, consist of several flanges of dural tubing joined together by diagonal tubes. The junctions are like those of the fuselage. The ribs also have the same kind of junctions in smaller dimensions and are also expensive to make.

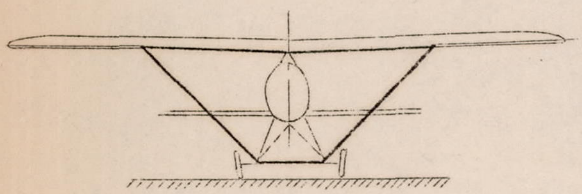
Translation by Dwight M. Miner,
National Advisory Committee
for Aeronautics.



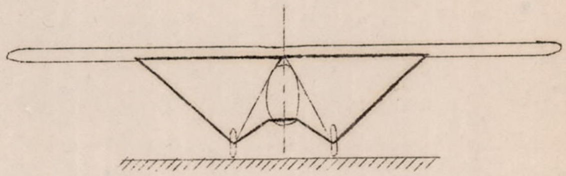
Farman



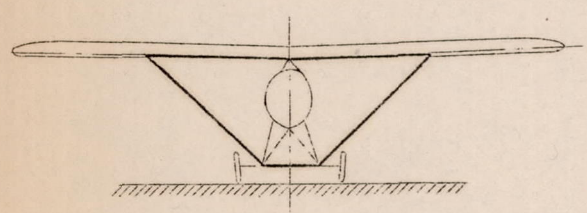
Béchereau



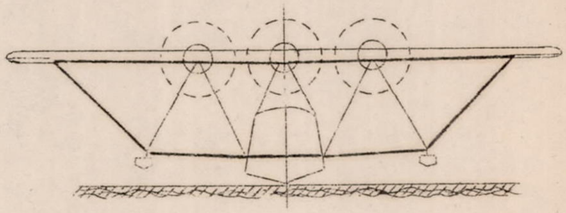
Nieuport-Delage



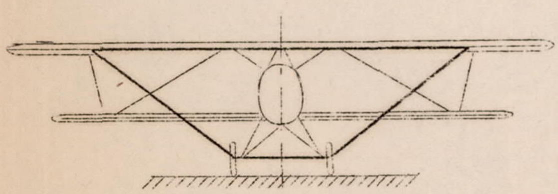
Mureaux



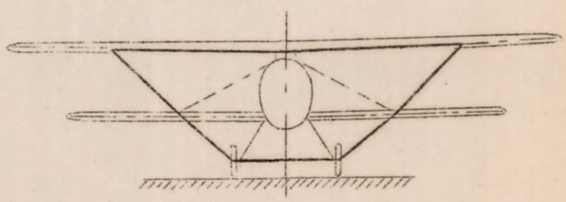
"Jockey"
Nieuport-Delage



Besson



Levasseur



Breguet

Fig.1

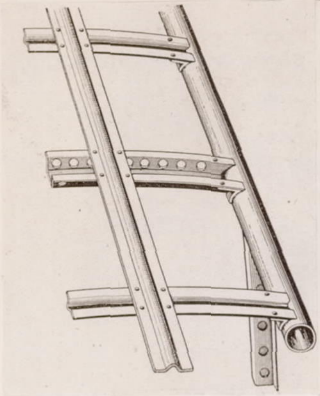


Fig.10

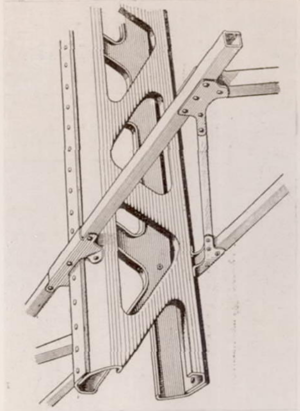


Fig.11

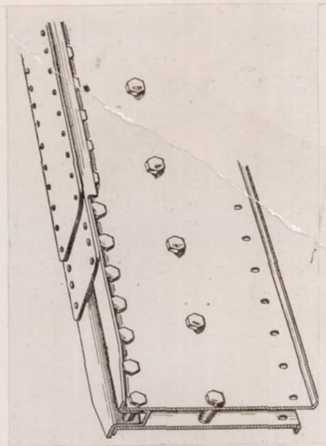


Fig.12

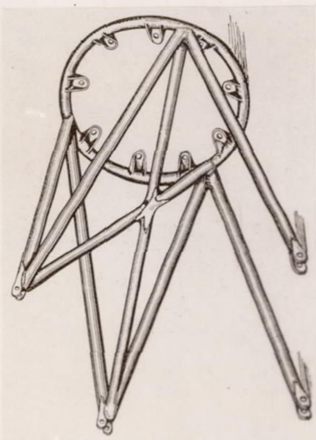


Fig.6

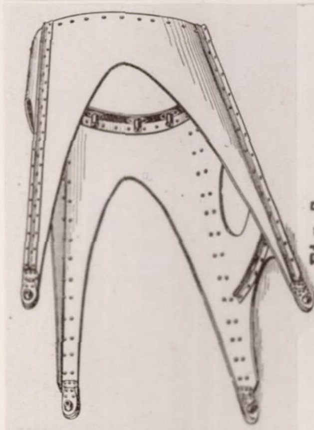


Fig.7

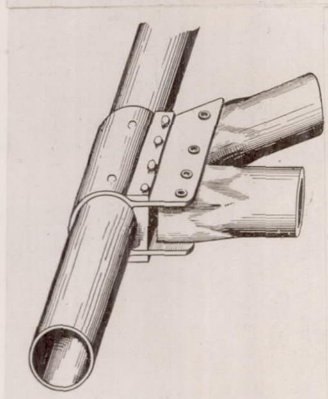


Fig.9

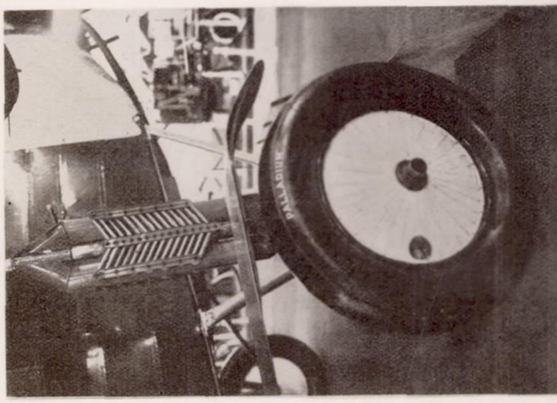


Fig.3

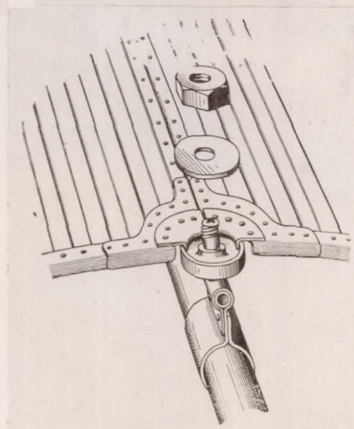


Fig.8

Fig.2

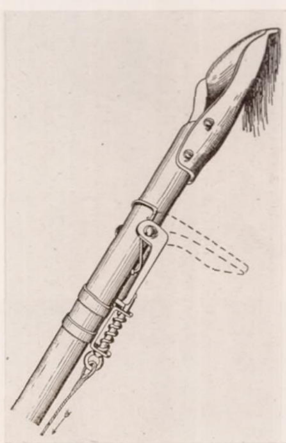


Fig.4

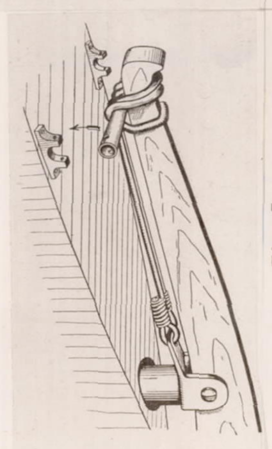


Fig.5

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